WHAT IS CLAIMED IS:

1. A method for measuring the velocity of a multiphase fluid flowing in a pipe, the method comprising:

(a) directing a pair of collimated beams of light from an illuminator through the multiphase fluid by means of transparent portions of the pipe, said pair of collimated beams spaced apart in a direction of flow of the multiphase fluid by a predetermined distance;

(b) detecting scattered, deflected and attenuated light with a pair of photodetectors to produce a pair of signals, each of said pair of photodetectors associated with one of said pair of collimated beams;

(c) calculating a cross-correlation function between said pair of signals to determine a time delay between the signals; and,

(d) calculating the average velocity of the multiphase fluid by taking the ratio of the predetermined distance to the time delay.

2. A method according to claim 1 further comprising passing the pair of signals through a plurality of band-pass filters to isolate a plurality of pairs of corresponding frequency components, each of the plurality of pairs of corresponding frequency components corresponding to one a plurality of flow components.

3. A method according to claim 2 further comprising, for each of said plurality of pairs of corresponding frequency components:

(a) calculating a cross-correlation function between the pair of corresponding frequency components to determine a time delay between the corresponding frequency components; and,

(b) calculating the velocity of the corresponding flow component by taking the ratio of the predetermined distance to the time delay between the corresponding frequency components.

4. A method according to claim 3 further comprising determining an intensity of each of said pairs frequency components and calculating an amount of a corresponding one of said plurality of flow components from said intensity.

5. A method according to claim 4 further comprising determining a flow rate of each of said plurality of flow components by multiplying the velocity of each flow component by the intensity of the corresponding pair of frequency components.

6. A method according to claim 5 wherein a vapour fraction of said multiphase flow is calculated as a flow rate of a fastest one of said plurality of flow components.

7. A method according to claim 6 further comprising determining a total flow rate of said multiphase flow by summing the flow rates of all of said plurality of flow components.

8. A method according to claim 7 further comprising calculating a quality of the multiphase flow by taking a ratio of the vapour fraction to the total flow rate.

9. An apparatus for measuring the velocity of a multiphase fluid flowing in a pipe, the apparatus comprising:

(a) an illuminator for generating a pair of collimated beams of light and directing said beams through the multiphase fluid

by means of transparent portions of the pipe, said pair of collimated beams spaced apart in a direction of flow of the multiphase fluid by a predetermined distance;

(b) a pair of photodetectors positioned across the pipe from said illuminator, each of said pair of photodetectors optically associated with one of said pair of collimated beams for detecting scattered, deflected and attenuated light from the associated beam and generating a signal; and,

(c) a signal processing means for processing the signals from said pair of photodetectors and calculating cross-correlation functions between the signals to determine a time delay, and for calculating the velocity of the multiphase fluid by taking a ratio of the predetermined distance to the time delay.

10. An apparatus according to claim 9 wherein said signal processing means comprises a plurality of band-pass filters for isolating a plurality of frequency components of each of the pair of signals.

11. An apparatus according to claim 9 wherein said illuminator comprises a first illuminator for generating a first pair of collimated beams, and wherein said pair of photodetectors comprises a first pair of photodetectors, the apparatus further comprising:

(a) a second illuminator for generating a second pair of collimated beams of light and directing said second pair of beams through the multiphase fluid at an angle to said pair of beams generated by said first illuminator; and,

(b) a second pair of photodetectors positioned across the pipe from said second illuminator, each of said second set pair of photodetectors optically associated with one of said

second pair of collimated beams for detecting scattered, deflected and attenuated light from the associated beam and generating a signal,

wherein said signals from said second pair of photodetectors are processed by said signal processing means.

12. An apparatus according to claim 11 wherein the angle is perpendicular.

13. An apparatus according to claim 9 further comprising at least one optical system for focusing light scattered at a near perpendicular angle from said pair of collimated beams from at least one measurement zone onto at least one photodetector.

14. An apparatus according to claim 9 further comprising a multi-focal optical system for focusing light scattered at a shallow angle from said pair of collimated beams from a plurality of measurement zones onto a plurality of photodetectors.

15. An apparatus according to claim 9 further comprising a multi-focal optical system for focusing light scattered at a near 180 degree angle from said pair of collimated beams from a plurality of measurement zones onto a plurality of photodetectors.

16. A method for measuring the velocity of a multiphase fluid flowing in a pipe, the method comprising:

(a) directing a pair of light sheets from an illuminator through the multiphase fluid by means of transparent portions of the pipe, said pair of light sheets oriented perpendicular to a direction of flow of multiphase fluid and spaced apart in the direction of flow by a predetermined distance;

(b) detecting scattered and deflected light with a pair of photodetectors to produce a pair of signals, each of said pair of photodetectors associated with one of said pair of light sheets;

(c) calculating a cross-correlation function between said pair of signals to determine a time delay between the signals;

(d) calculating the average velocity of the multiphase fluid by taking the ratio of the predetermined distance to the time delay; and

(e) calculating an amount of liquid fraction in the multiphase fluid based on dispersion of signals from said photodetectors.

17. A method according to claim 16 further comprising:

(a) directing at least one collimated beam in a direction generally parallel to said pair of light sheets;

(b) detecting deflected and attenuated light from said collimated beam with a reference photodetector to produce a signal associated with said collimated beam; and,

(c) calculating the amount of liquid fraction in the multiphase fluid based on dispersion of the signal from said reference photodetector.

18. A method according to claim 16 further comprising:

(a) directing at least one collimated beam in a direction generally parallel to said pair of light sheets, said collimated beam comprising light of a first wavelength with high absorbance in a liquid fraction and light of a second wavelength with low absorbance in the liquid fraction;

(b) detecting attenuated light with reference photodetectors to produce a first signal corresponding to light of said first

wavelength and a second signal corresponding to light of said second wavelength; and,

(c) calculating the amount of liquid fraction in the multiphase fluid based on a ratio of said first and second signals.

19. An apparatus for measuring the velocity of a multiphase fluid flowing in a pipe, the apparatus comprising:

(a) an illuminator for generating a pair of light sheets and directing said light sheets through the multiphase fluid by means of transparent portions of the pipe, said pair of light sheets oriented perpendicular to a direction of flow of multiphase fluid and spaced apart in the direction of flow by a predetermined distance;

(b) a pair of photodetectors positioned across the pipe from said illuminator, each of said pair of photodetectors optically associated with one of said light sheets for detecting scattered light from the associated light sheet and generating a signal; and,

(c) a signal processing means for processing the signals form said pair of photodetectors, calculating cross-correlation functions between the signals to determine a time delay, calculating the velocity of the multiphase fluid by taking a ratio of the predetermined distance to the time delay, and for calculating an amount of liquid fraction in the multiphase fluid based on dispersion of signals from said photodetectors.

20. An apparatus according to claim 19 further comprising:

(a) a reference illuminator for generating a collimated beam and directing said collimated beam through the multiphase fluid by means of transparent portions of the pipe;

(b) a reference photodetector positioned across the pipe from said reference illuminator and optically associated with said collimated beam for detecting attenuated light from said collimated beam and generating a signal, and;

(c) a reference signal processing means for processing said signal from said reference photodetector and calculating the amount of liquid fraction in the multiphase fluid based on dispersion of said signal.

21. An apparatus according to claim 19 further comprising:

(a) a reference illuminator for generating a collimated beam and directing said collimated beam through the multiphase fluid by means of transparent portions of the pipe, said collimated beam comprising light of a first wavelength with high absorbance in a liquid fraction and light of a second wavelength with low absorbance in the liquid fraction;

(b) reference photodetectors positioned across the pipe from said illuminator and optically associated with said collimated beam for detecting attenuated light from said collimated beam and generating a first signal corresponding to light of said first wavelength and a second signal corresponding to light of said second wavelength, and;

(c) a reference signal processing means for processing said first and second signals and calculating the amount of liquid fraction in the multiphase fluid based on a ratio of said first and second signals.